

# Fabric-reinforced concrete ground slabs and

In 2003, the Third Edition of Concrete Society Technical Report 34<sup>(1)</sup> was published. It brought together guidance for all types of industrial ground slab in one publication and also introduced a new design method for fabric-reinforced ground-bearing slabs. This article reviews results obtained by the new method and compares these with the results of past practice.

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For many years, the UK 'Bible' for designing concrete ground-bearing slabs was Colin Deacon's *Concrete Ground Floors: their design, construction and finish*<sup>(2)</sup>. Chandler's *TR550 Design of Floors on Ground*<sup>(3)</sup>, gave additional guidance on calculating slab thickness and was later refined by *BCA Interior Technical Note 1P*<sup>(4)</sup>, which introduced standard design loading categories.

The first and second editions of Concrete Society Technical Report 34 (1988, 1994) relied on TR550 for design of fabric-reinforced ground-bearing slabs but the Third Edition introduced a new, completely different design method.

- TR550 uses elastic analysis of slab bending capacity, whereas TR34/3 uses plastic analysis.
- According to TR550, 'a sub-base reduces the stress induced in the slab and, in the case of wheel and rack loads, assists in the distribution of the load to the sub-grade' (p.6) and ITN11, Table 1 gives enhanced subgrade properties for increased sub-base thickness. However, TR34/3 takes the opposite view: 'Any enhancement of the modulus of subgrade reaction produced by a compacted granular sub-base is so small that, compared with the variations in properties that will occur in a natural soil, it should be neglected in the design process' (6.4.1, p.35).
- In TR550 the safety factor on dynamic loads varies depending on number of load repetitions, to prevent fatigue failure, whereas in TR34/3 it is constant (9.6.3, p.54).
- In TR550 (p.9), assumed load transfer across a joint is 15% (single joint) or 30% (joint intersection). In TR34/3, it can be up to 50%.

## Comparison

The following analysis compares TR34/3 and TR550/ITN11 for a slab supporting ITN11:

'Category 2' (Medium) loading, with 3t forklifts (3.75-tonne wheel load, solid tyres) and 3-tonne racking legs (300mm c/c, 150mm from slab joint). Concrete cube strength is 40MPa, A142 fabric reinforcement (50mm bottom cover) and it is laid on 150mm hardcore. A 'good' subgrade with California bearing ratio (CBR) 15% ( $k = 60\text{MN/m}^3$ ) and a 'poor' subgrade with CBR 3% ( $k = 27\text{MN/m}^3$ ) are considered.

ITN11 Tables 1–7 give slab thicknesses for various loadings. In TR34/3, Section 9.9 gives load capacity based on bending, 8.8 and 9.10 discuss load transfer at joints, 9.11 covers punching shear and there is a worked example in Appendix E2 (E2 has an error: the average effective depth of a 175mm-thick slab with A142 fabric at 50mm cover is not 125mm – it is  $175 - 50 - 7 = 118\text{mm}$ ).

Several points are worth noting:

- In T34/3, variations in subgrade quality do not affect load capacity.
- On a 'poor' subgrade, a 170mm slab would be required by TR550/ITN11 but only 129mm by TR34/3.
- In TR550/ITN11, the slab fails in bending but in TR34/3 it fails in shear (curiously, despite this, TR34/3 devotes seven pages to bending analysis and only one page to shear).
- Based on TR34/3 moment analysis, a slab on a poor subgrade would only need to be 99mm thick.
- After permitted construction tolerances (slab level  $\pm 15\text{mm}$ , sub-base level  $\pm 0/-25\text{mm}$ ) a '129mm' slab may be only 114mm thick.

## Analysis

When a new design method gives radically different results from past practice, it should be checked carefully. TR34/3 introduces three major changes:

- bending strength is calculated from plastic theory instead of elastic theory.
- assumed load transfer at joints is increased
- slab load capacity is assumed to be the same at a joint intersection as at a single joint.

Table 2 compares allowable working loads (kN) based on bending analysis for a 150mm-thick slab with A142 mesh (150mm hardcore, subgrade CBR 3%, 40MPa cube strength, 100mm  $\times$  100mm racking leg base, tyre contact

Table 1 – Required slab thickness (mm) for various loadings

Subgrade Loading	CBR 15 Racking	CBR 15 3t Forklift	CBR 3 Racking	CBR 3 3t Forklift
ITN11	159	156	170	167
TR34/3 (shear)	129	129	129	129
TR34/3 (moment)	92	94	99	97

Table 2 – Allowable unfactored loads on 150mm slab (bending analysis, kN)

Load position	Internal rack leg	Internal wheel	Edge rack leg	Edge wheel	Corner rack leg	Corner wheel
TR550/ITN11	41	34	28	21	25	17
TR34/3	115	137	54	50	25	19

# Concrete Society Technical Report 11

**LL Leslie**



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